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SPACE TRAINING AND EDUCATION FOR USN CRYPTOLOGIC OFFICERS – THE ROAD TO SPACE CERTIFICATION

by

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September 2001

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SPACE EDUCATION AND TRAINING FOR USN CRYPTOLOGIC OFFICERS- THE ROAD TO SPACE CERTIFICATION

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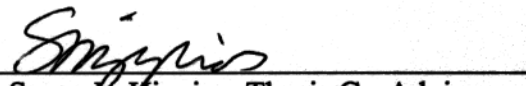
Approved by: 
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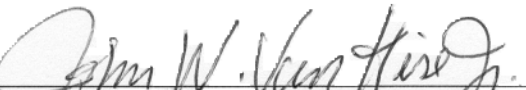
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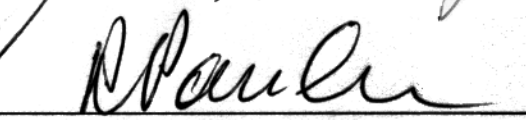
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ABSTRACT

This thesis discusses the importance of space-related education and training for Naval cryptologic officers in their efforts to support the warfighter. It includes a discussion of the learning continuum concept, an outline of cryptologic officer's career milestones for space-related training, and a discussion of the Navy's Distributed Learning initiatives. This thesis provides a framework for the establishment of a Space Certification Program for Naval cryptologists. The proposed Space Certification model was designed to allow expansion of the program to include Naval officers in other communities.

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LIST OF ABBREVIATIONS AND ACRONYMS

AAS	American Astronautical Society
ADL	Advanced Distributed Learning
AI	Aerospace Institute
AIAA	American Institute of Aeronautics and Astronautics
ATI	Applied Technology Institute
CBT	Computer-Based Training
CD-ROM	Compact Disc Read Only Memory
CESN	CNET Electronic Schoolhouse Network
CEU	Continuing Education Unit
CJCS	Chairman of the Joint Chiefs of Staff
CNET	Chief of Naval Education and Training
CNO	Chief of Naval Operations
CNSG	Commander Naval Security Group
CONUS	Continental United States
COQP	Cryptologic Officer Qualification Program
COTS	Commercial Off The Shelf
DAU	Defense Acquisition University
DAWIA	Defense Acquisition Workforce Improvement Act
DL	Distributed Learning
DoD	Department of Defense
DoN	Department of the Navy
EPPS	Electronic Performance Support System
FFRDC	Federally Funded Research and Development Center
IO	Information Operations
IT	Information Technology
IW	Information Warfare
ISIOC	Interservice Space Intelligence Operations Course
MILSATCOM	Military Satellite Communications
NAWCTSD	Naval Air Warfare Center Training Systems Division
NCOBC	Naval Cryptologic Officer Basic Course
NCS	National Cryptologic School
NEC	Navy Enlisted Classification
NRO	National Reconnaissance Office
NSA	National Security Agency
NSG	Naval Security Group
NSGA	Naval Security Group Activity
NTTC	Naval Technical Training Center
NTTS	Nontraditional Training Site
OCL	Office of Continuous Learning
PME	Professional Military Education

SATCOM	Satellite Communications
SIGINT	Signals Intelligence
SMC	Space and Missile Systems Center
SPAWAR	Space and Naval Warfare Systems Command
UCF	University of Central Florida
USAF	United States Air Force
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology & Logistics
USN	United States Navy
VTT	Video Teletraining

I. INTRODUCTION

The role of the 21st Century Naval cryptologist will be to provide support to the warfighter. As technological advances change the nature of war and how future wars will be fought and won, cryptologists will continue to utilize, and become more dependent upon, the medium of space in the performance of their duties. The Department of Defense, and thus the Navy, is not yet on course to develop the space cadre the nation needs and must create a stronger military space culture through focused career development, education and training [Ref. 1]. Whether or not Naval cryptologists eventually become part of the USN space cadre, it is the opinion of this author that Naval cryptologists require space education and training throughout their career if they are to master their duties in support of the warfighter.

A. BACKGROUND

The area of research for this thesis includes space education and training issues for U. S. Navy cryptologic officers. This thesis addresses in a broad perspective the need for cryptologists to have space education and training, when in a cryptologist's career the space education and training should take place, which general areas of space education and training are needed, and the format in which the education and training materials should be presented. Additionally, this thesis addresses in detail a proposal for a Space Certificate program that can be used not only for educating and training Naval cryptologists about space but can also be used for officers of other designators and for officers in other services.

B. OBJECTIVES

In specific terms, the objectives of this thesis were to:

- Examine the vast amount of information applicable to space-related education and training and decide what portion of it applies to Naval cryptologic officers. Included in this search were space-related courses

from the Naval Postgraduate School (NPS), the National Reconnaissance Office (NRO), the National Security Agency (NSA), Commander Naval Security Group (CNSG) cryptologic courses, U.S. Air Force space courses taught at Peterson AFB, Colorado Springs, CO, and Aerospace Institute (AI) courses. This information was used to recommend the course framework for a Space Certificate program.

- Examine the changing nature of training throughout the academic sector to explore alternatives for training other than the traditional classroom format.

C. RESEARCH QUESTIONS

The following research questions were addressed during the writing of this thesis:

- Why is space education and training important to cryptologic officers?
- What space-related education and training do Naval cryptologists need in the performance of their duties?
- When in a Naval cryptologist's career should space-related education and training be provided?
- What is the feasibility for developing a Space Certification Program for cryptologists?
- What should the program entail?

D. SCOPE, LIMITATIONS AND ASSUMPTIONS

The scope of this thesis was limited to analyzing space education and training requirements for cryptologic officers and intentionally excluded enlisted cryptologic technician personnel because:

- Officer's training is not as well defined as enlisted personnel's training and thus needs focused attention.

- Officer's training is more generalized throughout the force whereas enlisted personnel's training is more narrowly focused depending upon Navy Enlisted Classification (NEC).

Although the primary focus of this thesis was discussion of a space certification process for cryptologic officers, it is assumed that the conclusions and recommendations presented in the main body of the thesis can be applied to varying officer communities throughout the Navy and other services and need not be limited to USN cryptologic officers.

E. METHODOLOGY AND ORGANIZATION

The research method included a review of space-related education and training materials with a determination of their applicability to USN cryptologists at varying career points.

The following chapters will discuss the background leading to this thesis, the materials that were researched and reviewed, the core space education factors gleaned from the research, a discussion of training methods, a space certification proposal, and recommendations and conclusions.

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II. BACKGROUND

A. WARFIGHTING IN THE INFORMATION AGE

The primary purpose of America's Armed Forces has been and will be to fight and win the Nation's wars. As described in the Chairman of the Joint Chiefs of Staff (CJCS) document *Joint Vision 2020 America's Military: Preparing for Tomorrow*, the military must become a joint force that is intellectually, operationally, organizationally, doctrinally and technically superior to any adversary forces to be successful in accomplishing its mission in the year 2020. The concept of full spectrum dominance, the ability of U.S. forces to defeat any adversary and control any situation across the full range of military operations [Ref. 2], requires a joint team that integrates the specialized contributions of the individual services.

The quality of education and training provided to military personnel who will form this joint team will become increasingly important as they will be expected to participate in diverse missions using advanced equipment. The missions of 2020 will demand service members who can take advantage of intellectual and technological innovations which requires they integrate adaptability, innovation, precise judgment and forward thinking into their tactics. The complexity of the modern tools of war will require people who are both talented and educated and trained to exacting standards. [Ref. 2]

Many of the technological advances service members will be trained to master will involve the medium of space. The U.S. is more dependent on space than any other nation [Ref. 1] not only for commercial, social and civilian applications, but also to support the nation's strategic decision makers and to conduct military operations. Space-related capabilities help national leaders implement American foreign policy and, when necessary, use military power. Because of space capabilities, the U.S. is better able to sustain and extend deterrence to its allies and friends. Also, information gathered from and transmitted through space is an integral component of American military strategy and operations. Space-based capabilities enable military forces to be warned of missile

attacks, to communicate instantaneously, to obtain near real-time information that can be transmitted rapidly from satellite to attack platform, to navigate to a conflict area while avoiding hostile defenses along the way, and to identify and strike targets from air, land or sea with precise and devastating effect. Future military operations will be increasingly reliant on space systems, which will transform the conduct of these operations. The complexity of space systems that will be used to support future military operations is depicted in Figure 1. [Ref. 1]

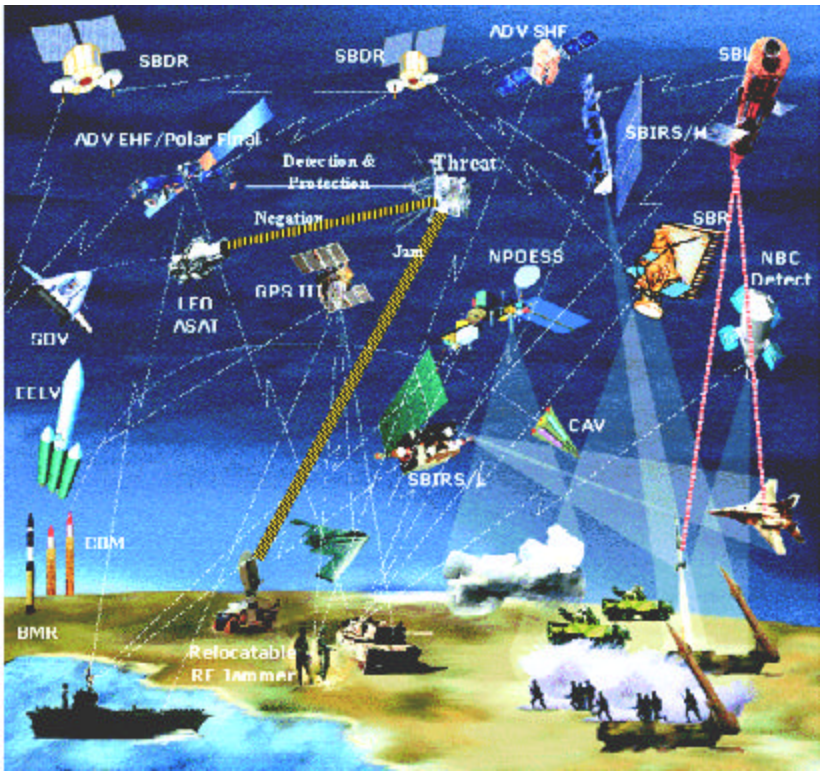

Figure 1. Space Systems Will Transform Future Military Operations (From Ref. 1).

Just as continuing education and advanced training for military personnel will be required for the effective operation of future weapons systems, continuing education and advanced training will also be required for military personnel to effectively utilize the medium of space. One of the findings from the *Commission to Assess United States National Security Space Management and Organization*, chaired by current Secretary of Defense Donald Rumsfeld (referred to as the Rumsfeld Space Commission henceforth),

was that the Department of Defense (DoD) and the Intelligence Community must place a higher priority on developing and sustaining a cadre of highly competent and motivated military and civilian space professionals. These space professionals are to be expected to master highly complex technology to operate some of the most complex systems ever built. They are also expected to develop new doctrine and concepts of operations for military uses of space including both offensive and defensive space operations [Ref. 1]. The Rumsfeld Space Commission recommended the U.S. Air Force be designated as the Executive Agent for Space within the DoD, but also recognized that each military service will need to continue to execute specific space programs. Thus each military component should comply with DoD space policy that requires the integration of space capabilities into strategy, doctrine, education, training, exercises and operations. Additionally, the Rumsfeld Space Commission recognized that the Navy, as well as the other services, needs to continue to provide appropriately qualified officers to joint commands and agencies, including the NRO, the U.S. Space Command, and the office of the National Security Space Architect. This will ensure that these agencies and commands have staff qualified to understand and meet each services requirements for space systems and products. In light of these expected continuing requirements, all of the military services, including the Navy, will need to maintain a cadre of space-qualified officers to represent their interests in space requirements, acquisition and operations as well as to oversee the deployment, funding and, where appropriate, operation of space systems. [Ref. 1]

B. IMPORTANCE OF SPACE IN NAVAL CRYPTOLOGISTS' EFFORTS TO SUPPORT THE WARFIGHTER

Intelligence collection from space remains essential to the mission of the Intelligence Community. The need for access to denied areas persists as it has in the past. The Intelligence Community and the DoD deploy satellites to provide global communications capabilities; verify treaties through "national technical means"; conduct photoreconnaissance; collect mapping, charting, geodetic, scientific and environmental data; and gather information on natural or man-made disasters [Ref. 1]. The U.S. Intelligence Community also collects signals intelligence and measurement and signature

intelligence from space. This intelligence is essential to the formulation of foreign and defense policies, the capacity of the President to manage crises and conflicts, the conduct of military operations and the development of military capabilities to assure the attainment of U.S. objectives [Ref. 1].

Collection from space will continue to be critical to meeting difficult intelligence collection challenges. To be the world's premier military force in the year 2020, it will be necessary for the U.S. to meet these intelligence collection challenges by investing in space-based technologies that will enable the U.S. to stay at least one technology generation ahead of its adversaries. Due to its heavy reliance on space assets, the U.S. must also develop and maintain intelligence collection capabilities that will assist in understanding the intentions, motivations and capabilities of potentially hostile states to deny, disrupt or destroy U.S. space systems. Adversaries could attempt to adversely affect U.S. space systems by attacking satellites in space, the communications links to and from the ground, or ground stations that command the satellites and process their data [Ref. 1]. To achieve the goal of providing better space collection assets to meet future defense and intelligence challenges, the Department of Defense and the Intelligence Community are in the process of replacing most of their satellite inventory over the next decade. These programs are estimated to cost more than $60 billion during this period [Ref. 1]. Figure 2 on page 9 shows the extent of this modernization effort.

Just as the Intelligence Community relies on space-based assets to support the President and the rest of the DoD, Naval cryptologists also rely on space to provide signals intelligence collection for supporting the warfighter. As the battlefield of the future is transformed by the increased use of space assets, cryptologists will need to increase their knowledge of space and space systems in order to provide information that is relevant and meets the warfighter's requirements. Naval cryptologists will require a working knowledge of space and space assets to leverage the information provided by these assets in formulating a response that reflects an understanding of how signals intelligence fits into the overall space information arena.

It is not presently known how the U.S. Navy will proceed with developing a space cadre and whether or not some Naval cryptologists will become part of this cadre of

space professionals. As part of the Naval Security Group (NSG), Naval cryptologists are responsible for performing cryptologic and related functions in support of the warfighter and in support of national cryptologic organizations. For the foreseeable future, Naval cryptologists will continue to be called upon to participate in joint and staff assignments that require previous space education and training. The cryptologists that fill these assignments will need to be prepared with the requisite space-related information to develop strategies to ensure Naval requirements in space continue to be met in the future.

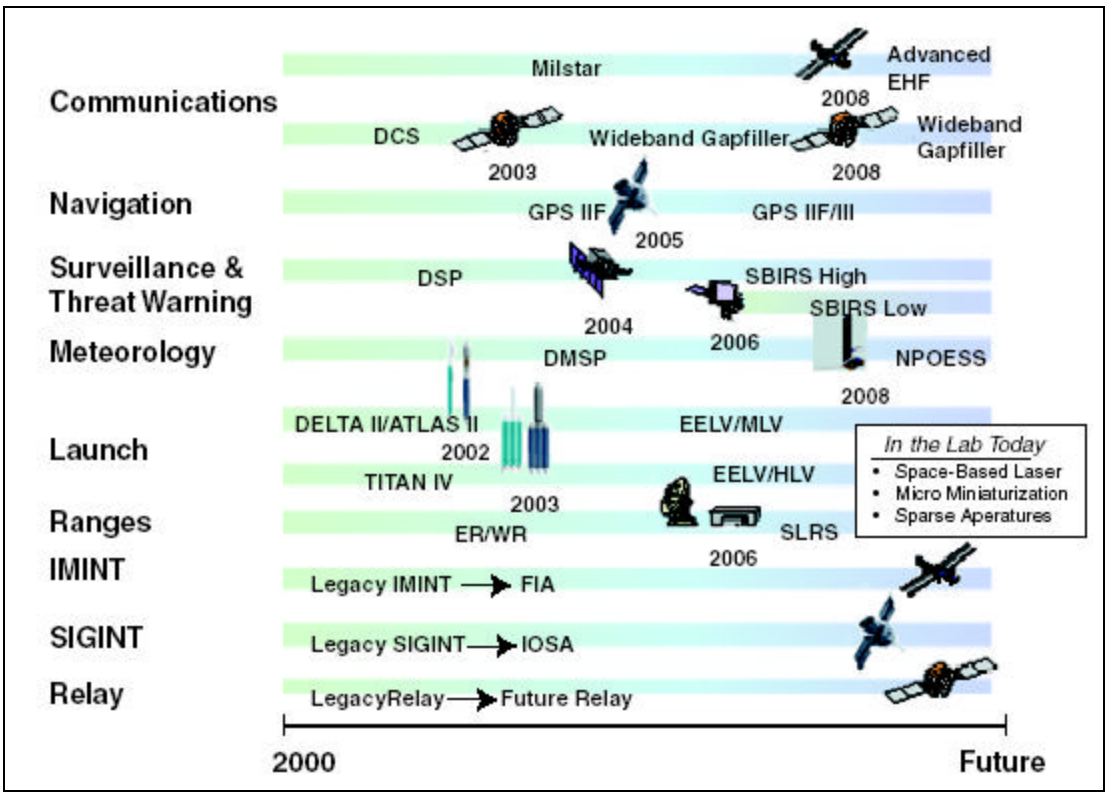

Figure 2. Modernization Program for National Security Space Systems (From Ref. 1).

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III. LITERATURE REVIEW

This chapter discusses a review of the literature pertinent to the framework of the research and gives a brief discussion of the significance of this literature to the study presented.

A. THE RELEVANCE OF SPACE

In attempting to answer the question of why Naval cryptologists need to be educated and trained in space related topics, CJCS Joint Vision 2020, as well as the Rumsfeld Space Commission Report, were used to establish how space plays a role in support to the warfighter both today and in the future. Joint Vision 2020 discusses the more technical role service members will need to assume to fight and win wars in the year 2020. The Rumsfeld Space Commission Report discusses the important role space will play in future conflicts and the need for the DoD to establish a core group of military and civilian personnel who will become space experts.

B. SPACE EDUCATION CORE

The basic space education core disciplines were compiled from the content of current space-related courses. The courses included in this research were from a variety of organizations. These organizations and their missions follow:

- The Naval Postgraduate School. The NPS is an academic institution designed to meet graduate education requirements of military officers and government civilian employees from the U.S. and other countries. The graduate study programs are primarily designed to prepare these individuals for future career assignments.
- National Reconnaissance Office. The NRO is the organization responsible for the large-scale systems engineering, development, acquisition, and

operation of space reconnaissance systems and related intelligence activities needed to support global information superiority.

- National Security Agency. The NSA is the organization responsible for the Nation's cryptologic efforts. The NSA coordinates, directs, and performs highly specialized activities to protect U.S. information systems and produce foreign signals intelligence information.
- Aerospace Institute. The AI is the educational establishment of the Aerospace Corporation, a nonprofit corporation that provides research, development and advisory services to government agencies with space-related programs. The mission of the Institute is to promote learning to enhance the Aerospace Corporation's capabilities as a national center for space technology, systems architecture, and engineering.

Additionally, current Naval cryptologic courses including the Naval Cryptologic Officer Basic Course (NCOBC), the Annual O-4/O-5 Seminar offered at Naval Security Group Headquarters, and the Cryptologic Officer Department Head Course, which is currently under development, were reviewed for content. Also, the content of the Interservice Space Intelligence Operations Course (ISIOC), a space operations course provided by the U.S. Air Force (USAF), was reviewed.

C. THE LEARNING CONTINUUM AND TRAINING METHODOLOGIES

To answer the research questions related to when space education and training is needed in a cryptologist's career and in what format the education and training should take place, a review of literature related to learning continuums, distributed learning (DL), computer-based training and web-based training was conducted.

The concept of a learning continuum, or more simply stated the continuous learning that takes place throughout an individual's career, was refined by researching various educational publications available via the World Wide Web. This research led to the observation that not only can individuals continue to learn throughout a lifespan, but also organizations can be developed that enhance this continuous learning. These

organizations are termed learning organizations as described in by Peter Senge in *The Fifth Discipline,* which was used as a launching point for exploring how an organization can become a learning organization.

To assess what format the education and training materials used in a space certification program should take, the Navy's Distributed Learning Strategy as well as the Web-based Education Commission report, *The Power of the Internet for Learning: Moving from Promise to Practice*, were reviewed. Both documents were used in establishing a web-based approach to the space certification process.

D. SPACE CERTIFICATION PROGRAM

A variety of resources were used to reach conclusions and to make recommendations for future navy space-related courses. The Under Secretary of Defense for Acquisition, Technology and Logistics (USD (AT&L)) Policy on continuous learning for the Defense Acquisition Workforce was used as a model for recognizing the need for distributive learning programs and for establishing a distributive learning program. Also, the Aerospace Institute's Aerospace Systems Architecting and Engineering Certificate Program served as a model for establishing a proposed Space Certification Program.

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IV. SPACE EDUCATION CORE

Several space-related courses were reviewed and used as a basis to determine what cryptologic officers need to know about space. These courses included current Commander Naval Security Group cryptologic courses, as well as space-related courses offered by the NPS, the NRO, the NSA, the Aerospace Institute and the U.S. Air Force. While there are numerous other space-related courses available in both the government and commercial sectors, the courses chosen were considered to be a representative sample of courses available for incorporation into a Space Certification Program.

A. BASIC COURSE CONTENT

An analysis of courses designed to provide basic space-related topics revealed that course content differed depending upon the length of the course and the student audience. Table 1 below provides an overview of the topics presented in introductory space-related courses by various organizations.

Organization	Course	Topics Presented in Basic Space-Related Courses
CNSG	Naval Cryptologic Officer Basic Course (NCOBC)	Orbitology, U.S. Space Organizations, Operational Space Systems, U.S. Launch and Recovery Systems, Satellite Vulnerabilities, National Space Systems
NPS	Space Systems Technology and Applications (SS3011)	Introduction/Orientation (why we use space systems), Space System Elements (basic terminology), Space Environment, Orbital Motion, Orbital Elements, Predicting Orbits, Satellite Ground Tracks and Missions, Launch, Satellite Communications I, Satellite Communications II, DoD Uses of Space Systems, Space Organizations, Space Control, Planning for Operational Use of Space Systems
NRO	Various Introductory Courses	NRO Organization, NRO Systems Support, Support to Military Operations, Orbital Mechanics, Data Distribution, Signals Intelligence, Imagery Intelligence, Measurement and Signature Intelligence
NSA	Various Introductory Courses	Artificial Satellites, Physics of Satellites, Physics of Orbits, Coordinate Systems, Orbital Elements, Time Systems, Ephemeris Data, Perturbations, Earth Satellite Orbits and Ground Traces, Orbital Launch and Maneuver, Satellite Subsystems, Tracking and Telemetry
Aerospace Institute	Various Introductory Courses	Space Environment, Astrodynamics, Missions, Payloads, Launch Vehicles, Spacecraft, and Payloads
U.S. Air Force	Interservice Space Intelligence Operations Course (ISIOC)	Orbital Mechanics, Operating in the Space Environment, International Space Law, Military Space Organizations and Missions

Table 1. Topics Taught at Various Space-Related Courses.

It was noted that the general topic areas of these introductory space/satellite courses differ depending upon the organization providing the course. However, there are also great similarities. If it were possible to consolidate these basic courses into one course that would provide a space-related overview for Naval cryptologists, the following topics would constitute a representative core: Orbitology/Orbital Mechanics, U.S. Space Organizations, Operational Space Systems to include National Space Systems of the NRO, U.S. Launch and Recovery Systems, Satellite Vulnerabilities, Space Environment, Satellite Ground Tracks and Missions, Satellite Communications, Data Distribution, DoD Uses of Space Systems, Space Control, Planning for Operational Use of Space Systems, Space-related Intelligence, Satellite Subsystems, Payloads, Tracking and Telemetry.

B. "BEYOND THE BASICS" CONTENT

In addition to the core courses mentioned in the above paragraph, each of the organizations studied also provided more advanced courses that were pertinent to their specific mission. A brief description of the focus of the more advanced space-related courses offered by these organization's follows:

- Naval Postgraduate School. The NPS offers courses leading to a Master of Science degree in Space Systems Operations. The Space Systems Operations curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, including space surveillance, communications, navigation and atmospheric, oceanographic, and environmental sensing systems, as well as a knowledge of payload design and integration.
- National Reconnaissance Office. The NRO offers operations courses that focus on teaching students how to operate the systems and software used in their satellites. These courses also provide information on how to use the data provided by the NRO systems.

- National Security Agency. The NSA offers courses that fall under the satellite technology umbrella and focus on signals intelligence issues.
- Aerospace Institute. The AI offers courses as part of either the Space Systems Architecting, Acquisition, and Engineering discipline, or the Space Technologies and Engineering discipline. Many of these courses are advanced engineering courses.

These more advanced space-related courses were considered as candidates for inclusion into a Space Certification Program.

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V. CAREER PATH LEARNING CONTINUUM

A. LEARNING CONTINUUM AND LEARNING ORGANIZATIONS

In its simplest form, a learning continuum can be viewed as all of the learning processes an individual experiences throughout his or her lifespan. For the purposes of this thesis, a learning continuum will be considered synonymous with a training continuum as well as an educational continuum. In academia, there is often the impression that learning is something that occurs in finite sessions and is not part of a larger learning continuum. However, learning need not be a linear event where a learner goes to a formal learning program, gains areas of knowledge and skills about a process, and then the learning ceases [Ref. 3]. If an individual can view life, including work, as a "learning program", then that person can continue to learn from almost everything in life. In other words, involvement in a learning continuum is more than just attending one course after another, gathering more and more information. It includes the application of the information gained in various courses to real life work. As demonstrated in Figure 3 on page 20, a learning continuum can also be considered as the entire process an individual will experience as he or she develops into a subject matter expert from a novice [Ref. 4]. This process unquestionably involves more than just attendance in a formal course. It also includes application of the course content to daily tasks.

The concept of a learning continuum is something that has already been embraced by the Director of Naval Training (N7), Chief of Naval Operations (CNO). This continuum has been defined as the career long learning continuum that involves technical skills and warrior training, professional and leadership development and education for each service member. CNO (N7) has further advanced the learning continuum concept to include the vision that each Navy member will have a learning profile and a career education and training plan that clearly identifies the knowledge and skill required for performance in critical positions across one's career. [Ref. 5]

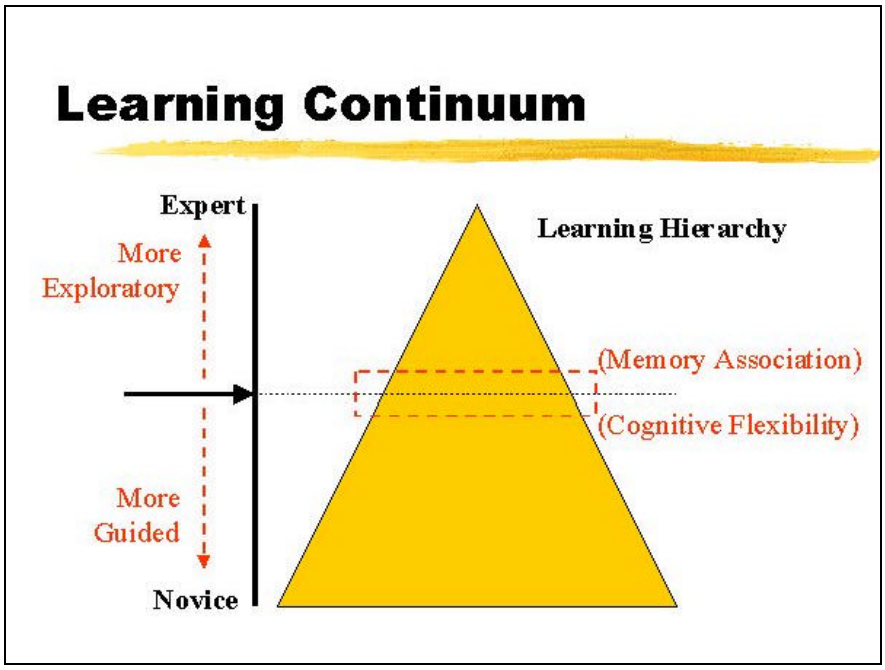

Figure 3. The Learning Continuum (From Ref. 4).

Just as an individual can commit him or her self to participating in a learning continuum, organizations can also establish structures and processes that cultivate continuous learning [Ref. 3]. These organizations can then be defined as learning organizations because they assume that learning is valuable, continuous and most effective when shared and that every experience is an opportunity to learn. A learning organization promotes the culture of learning, a community of learners, and it ensures that individual learning enriches and enhances the organization as a whole. For an organization to learn, the individuals within that organization must learn, and most importantly, the individual learning must be shared and used by the organization. [Ref. 6]

For an organization to achieve the status of being a learning organization, five disciplines must be observed: personal mastery, mental models, shared vision, team learning, and systems thinking. These five disciplines were described by Peter Senge in *The Fifth Discipline* [Ref. 7].

Personal mastery is the concept of having a personal vision that is continually updated and clarified. The vision is based on realistic observations of the world and includes a focusing of energies to achieve the vision. Senge claims that personal mastery is the cornerstone of a learning organization because by encouraging personal mastery, an organization allows its individuals to develop a capacity for learning. [Ref. 7]

Mental models are deeply ingrained assumptions and generalizations that individuals or organizations use to view the world. Mental models that an organization has based its developmental decisions on for years can often be barriers to accepting new and innovative practices. Senge believes that by revising mental models, organizations can encourage employees to think and speak openly. [Ref. 7]

The shared vision discipline describes how leadership can inspire people within an organization to excel and learn. When people have a clear picture of what the goals of an organization are, they work hard, not because they have to, but because they want to. However, Senge goes on to explain that the vision must not be something that is dictated by leadership but must be something that the employees have embraced as their own. [Ref. 7]

Team learning is the idea that a group problem solving effort can produce dramatically better results than when individuals work alone to try to solve the problem. Also, not only does the team perform at a much higher level but also the individuals are growing and learning more rapidly than if they were working on their own. To master team learning, groups must have free and creative exchange of ideas (dialogue) and must have the ability to present and defend different views (discussion), and must know when to use each of these tools. [Ref. 7]

Systems thinking is the ability to view and understand how a system functions as a whole, not by breaking the system down and looking at each individual part, but by understanding the conceptual framework of the system [Ref. 7]. Systems thinking is the most important of the five disciplines and is approached by focusing on how an item being studied interacts with the other parts of the entire system. Systems thinking helps to solve complex problems by allowing people to see the “big picture” of the problem and not just their part of it. [Ref. 8]

Building a learning organization is an enormous task, but is one that begins with the attitude that learning is a sustainable resource, not a limited commodity. The organization must then develop the mindset of a culture of learning. The barriers that prevent a learning organization from becoming a reality are ineffective leaders, inability to change, learned helplessness, tunnel vision, individualism and a culture of fear and disrespect [Ref. 6]. It has also been noted that a learning organization cannot be developed when downsizing or layoffs are occurring because the mindset of the employees is not conducive to developing a learning culture [Ref. 6].

As noted earlier, a learning organization is one in which learning is valued. Employees are not only encouraged to learn but are provided opportunities to learn. A space certification process could be the mechanism the cryptologic community uses to provide space-related learning opportunities. By employing a space certification program, the cryptologic community could demonstrate that it values space-related education and training.

B. CAREER MILESTONES FOR SPACE-RELATED TRAINING

Space-related training for cryptologists is made available at varying career points and is mainly conducted as part of formal schoolhouse instruction. These education and training milestones are, for the most part, finite courses that are not integrated as part of a learning continuum. These milestones were reviewed in an effort to understand what space-related education and training is currently provided to Naval cryptologists prior to making recommendations for additional education and training via a Space Certification Program. The following paragraphs briefly describe these career points.

1. Navy Cryptologic Officer Basic Course (NCOBC)

The NCOBC is designed to provide new accessions into the cryptologic community general knowledge of the subject areas that are important to Naval cryptology. One of the core subject areas is Satellite Fundamentals, which gives beginning cryptologist the basic technical and operational information related to space.

2. Cryptologic Officer Department Head Course

This course is currently under development and will be designed for mid-level cryptologic officers to enhance their technical and professional backgrounds. The space portion of this course will most likely be a core competency update that builds on the basics provided in the NCOBC.

3. O-4/O-5 Seminar

The O-4/O-5 Seminar is designed to provide an updated look at technology trends important to cryptologists and provides a broad perspective of the cryptologic community and the technical opportunities emerging, including space-related technologies.

4. Professional Development

The Cryptologic Officer Qualification Program (COQP) is a structured professional development program that is designed to ensure each cryptologic officer learns the fundamental skills required to function effectively in various assignments. New accessions into the cryptologic restricted line community must participate in the COQP. New accessions are assigned the 164X designator, which is a cryptologist in training, and they earn the 161X designation upon completion of the qualification program. The eight core competencies that broadly define a cryptologist's fundamental skills are target knowledge, digital data communications, computers, electromagnetic spectrum, radar systems, communication systems, and satellite systems.

C. EDUCATION AND TRAINING FORMAT FOR SPACE CERTIFICATION

In the past, military education and training courses have typically been designed for a schoolhouse environment. Instructors have generally led students, and for the most part, students have been expected to proceed at a group pace. The military services have had a great tradition of using correspondence courses in print form to augment, and in

some cases replace, classroom instruction. With the advent of the World Wide Web and the Internet, as well as the proliferation of personal computers, other options for conducting education and training courses have been implemented. These options are known by a variety of terms including computer-based training, web-based training, on-line courses, Internet-based training, Net-based training, E-learning courses, etc. For the purposes of this thesis, the term web-based training will be used to include any training that involves the use of any on-line resource such as the World Wide Web or the Internet. Not included in this definition are computer-based training (CBT) courses, which include the use of a CD-ROM, or courses that include the use of computers in an instructor-led classroom environment.

Although a number of initiatives are currently ongoing to apply technology to reduce the cost and time to train, the preponderance of education and training in the Navy continues to be delivered in the traditional instructor-centered group-paced mode. For example, Professional Military Education (PME) continues to be presented through lengthy resident or traditional non-resident curricula. Existing and emerging information technologies provide an excellent opportunity to deliver flexible and adaptable solutions that employ world-class integrated instructional and informational technologies. [Ref. 5] The proposed space certification process for cryptologists addressed in this thesis and outlined in detail in Chapter VI, attempts to incorporate nontraditional education and training resources. The majority of the classes proposed for use in the certification process are distributed learning courses that utilize a web-based approach. The distributed learning concept, as well as a web-based approach to education and training, are discussed in the following paragraphs.

1. Distributed Learning

Distributed learning was originally known as correspondence study and involved the distribution of course materials through the mail. Distributed learning now encompasses a wide variety of methods for delivering education and training materials including print, audio, video and web-based methods. For many years, DL has played a key role in the education and training of military service members who are

geographically dispersed throughout the world. An increased shift to DL as a means of educating service members has been driven by the need to reduce training costs while increasing accessibility to information typically presented in a classroom environment [Ref. 9]. Although all of the military services have a plan to increase the role DL plays in the education and training of soldiers, sailors and marines, the U.S. Navy's Distributed Learning strategy was examined for this thesis.

The Navy's strategy is to go from its current "in-residence" focused education and training environment to a global DL system designed to deliver training, education, and information "on demand" as a continuum to support Naval operational readiness. The DL strategy is a key piece to re-engineering Naval education and training to facilitate the Navy's Strategic Training vision to deliver quality education and training to the right people at the right time and at the right place. The system concept for Navy DL is three-dimensional: 1) to provide learning environments across time and space, 2) to manage the learners and learning to ensure readiness across career continuums, and 3) to provide decision support through data warehousing and decision support tools [Ref. 5]. The benefits the Navy hopes to realize for developing the DL system will be shortening in-residence requirements, expanding education and training opportunities, accommodating changing demographics, making proficiency training readily available Navy-wide, and saving TAD costs. The Navy's DL strategy will be accomplished through a variety of media including paper-based instruction, multimedia instruction, compressed video, various Electronic Performance Support Systems (EPPS), and simulation. [Ref. 5] An EPPS is a system that structures and presents information so people can access information right when they need it to accomplish workplace tasks. In addition to information, an EPPS can provide tools, processes, expert advice, coaching, feedback, and so on. Essentially, an EPPS uses technology to integrate knowledge and learning experiences with software tools to provide the learning experiences needed to improve performance [Ref. 10].

The system concept for how the Navy's DL system will be implemented is demonstrated in Figure 4 on page 26. The system is designed to support delivery of education and training to: 1) classrooms within schoolhouses, 2) shore-based Fleet Readiness Centers, 3) ships in port, 4) ships at sea, 5) sailors' homes [Ref. 5]. The Navy

plans to integrate with non-Navy learning systems, including industry and higher education institutions, in Extranet and Internet configurations while maintaining internal integrity via Intranets, to form its DL system. Additionally, the capability to access references and on-line libraries such as those at the Naval War College and the Naval Postgraduate School will also be included. As shown in Figure 4, an integral part of the DL system concept is the Chief of Naval Education and Training (CNET) Electronic Schoolhouse Network (CESN). The CESN currently delivers education and training via video teletraining (VTT) to numerous sites throughout the Continental United States (CONUS) as well as to sites such as the USS CARL VINSON [Ref. 5].

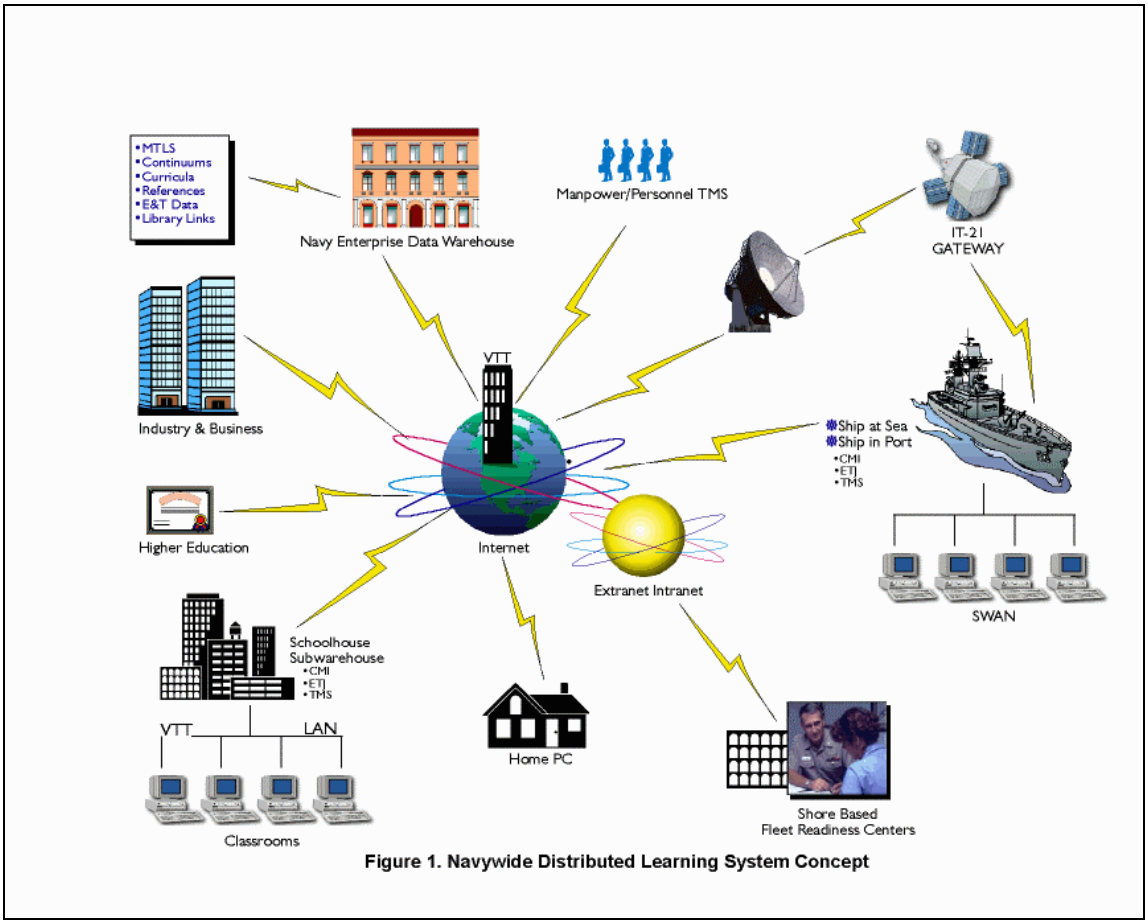

Figure 4. Navy wide Distributed Learning System Concept (From Ref. 5).

For developing the DL system, the Navy also plans to partner with other DoD, government, academic, and industry organizations to leverage existing DL and related management efforts. Also, the Navy plans to make maximum use of commercially available technologies, services, information and instructional materials. Specifically, the Navy plans to leverage include the following:

a. The Advanced Distributed Learning (ADL) Initiative

The Advanced Distributed Learning (ADL) Initiative is a joint DoD and White House Office of Science and Technology Policy initiative of 1997. The purpose of the ADL initiative is to provide access to high-quality education and training materials that can be tailored to organization or individual learner needs and can be made available when and where they are needed. A goal of this initiative is to accelerate large-scale development of learning software to meet the education and training needs of the military and the nation's workforce in the 21st century. The initiative will accomplish this goal through the development of a common technical framework for computer and net-based learning that will foster creation of re-usable learning content as "instructional objects" [Ref. 11]. These instructional objects are part of the object-oriented programming environment that involves the creation of "objects" which are self-contained entities that consist of both data and procedures to manipulate the data. Using the object-oriented approach, instructional objects can be created by one organization and then reused by another organization by simply applying modifications to the already built object. ADL will ensure that a common set of guidelines will be in place for the creation of instructional objects to facilitate their reuse [Ref.11].

b. Non-traditional Training Site (NTTS) Program

The Navy also plans to leverage its own experience with the Non-traditional Training Site (NTTS) program. An NTTS is defined as any source of training provided outside of formal CNET schools (i.e., colleges, Navy and private shipyards, Shore Intermediate Maintenance Activities, vocational/technical schools, etc.,) to Navy

personnel that satisfies a valid training requirement. The NTTS selected as a source of training may use either Navy-provided curriculum or its own curriculum materials. [Ref. 5]

While the DL system is envisioned to provide a means to achieve the goal of providing education and training to sailors when needed, it will take more than just simply moving a classroom course to one of the many possible DL formats in order for the program to be considered a success. As recognized by the CNO (N7), to effectively implement DL the Navy must move toward the concept of a career learning continuum that identifies blocks of training and education for career development, operational needs, and personal growth from accession until the member leaves the service. Career learning continuums will need to be developed to integrate the requirements for basic training, technical training, operations technical training, mission training, and education for both active and reserve officer and enlisted personnel. Distributed Learning cannot meet the challenge of delivering the right learning opportunity to the right person at the right time unless each individual has a career path that identifies specific training and education required at various career stages. [Ref. 5]

2. Web-based Approach to Education and Training

Web-based classes are becoming a predominant form of providing education and training materials to many organizations, both civilian and military. Because of the widespread growth of Web-based approaches, the U.S. Congress established the Web-based Education Commission in 1999 to maximize the educational promise of the Internet for all students from pre-kindergarten to postsecondary [Ref. 12]. This commission authored a report titled *The Power of the Internet for Learning: Moving from Promise to Practice*, which was released on December 19, 2000.

The Web-based Education Commission report is the most comprehensive ever written on the impact of web-based learning on education, establishes a "policy roadmap" that will help education and policy officials at the local, state, and national levels better address the critical "digital age" challenges brought about by the Internet and other

emerging technologies [Ref. 12]. This report was used as the primary reference to support the decision to incorporate mostly web-based courses into the space certification process. The justification is discussed below:

- The Need for Continuous Training. Continuous training is a key component of any education and training process that incorporates the learning continuum concept. It is estimated that 50% of all employees' skills become outdated within 3 to 5 years from initial establishment [Ref. 12]. To deal with this, a shift to web-based training from classroom training is taking place in the corporate environment. Classroom use in corporate training is expected to drop from the current level of 78% to 64% by the end of 2001 [Ref. 12]. Additionally, more corporations are establishing corporate universities to address the educational and training needs of their workers. In the last thirteen years the number of companies that have opened corporate universities grew from 400 to 1,800, and 40% of Fortune 500 companies have established corporate universities [Ref. 12]. At the current rate the number of corporate universities will exceed the number of traditional universities by the year 2010 [Ref. 12]. The space certification process should incorporate the web-based training approach as a continuous learning strategy.
- Paths to learning differ. Research has shown that there is not one "typical" learner, just as there is not one path to learning. Web-based learning environments can provide support and challenge through multiple means of representation, expression and engagement [Ref. 12]. By providing a means to represent a concept in more than one format, i.e., text and graphic, web-based learning provides students who may have different methods of learning with increased opportunities to understand the concepts being presented. Through the use of writing, drawing, sound, images or combinations of these media, web-based learning provides students with different modes of expression to demonstrate that they have a grasp of the concept being presented. Also, students can become more engaged in a web-based environment because the tools available can be

used to attract the easily bored or the easily distracted learner who does not fare well in a traditional classroom environment. The space certification process should incorporate web-based training to allow different learning paths for individuals involved in the certification process.

Other reasons exist for including a web-based approach into the space certification process. Web-based classes reduce training expenses by reducing classroom training, they eliminate travel expenses, and they reduce time employees are away from their jobs. These same reasons are germane to the cryptologic community, as well as to the entire Navy. An additional reason for including web-based training in the certification process is that web-based initiatives will provide accessibility to courses regardless of where a cryptologist is stationed.

While many reasons have been provided for including a web-based approach in the space certification process, there are drawbacks to this approach that must be noted. Some students do not thrive in the web-based environment and may feel overwhelmed by the amount of information that is available to them. Also, students may feel isolated and become frustrated when they don't get immediate instructor feedback [Ref. 13]. Additionally, there are two items that, while not considered drawbacks, are key considerations that must be taken into account before developing a web-based class. The first is the process that must be followed to develop a web-based class, and the second is the process that faculty must undergo to learn how to teach in a web-based environment. Both of these items were not specifically addressed in this thesis for the proposed space certification program, but are considered to merit future exploration and are briefly addressed in the Appendix.

VI. SPACE CERTIFICATION PROGRAM

This chapter proposes a Space Certification Program for cryptologists and provides content recommendations for such a program. The framework for the certification program is intended to be easily transferred to officers in other communities within the USN.

A. OVERVIEW

The Space Certification Program for Naval cryptologists is proposed as a program that combines education and training coursework, on-the-job experience and professional development to provide within the CNSG workforce a group of individuals with space expertise. It provides an avenue for space-related education and training certification initially to Naval cryptologists and, in the future, to officers within the Navy's space cadre, regardless of their designator. It outlines a strategy that incorporates a learning continuum approach by following the Navy's Distributed Learning policy. This strategy seeks to minimize the traditional classroom instructional method in order to increase the number of possible participants in the program.

B. DESCRIPTION OF MODELS USED FOR SPACE CERTIFICATION DEVELOPMENT

Provided in this section of the thesis is a description of the two models used to create a proposed space certification program. Elements of each of the two models were incorporated into the proposed framework.

1. Defense Acquisition Workforce Model

In 1991, the Defense Acquisition Workforce Improvement Act (DAWIA) required the DoD to prescribe regulations for the educational development of personnel in acquisition positions [Ref. 14]. These regulations were designed to ensure that acquisition personnel have the knowledge and skills necessary to perform effectively in

multiple defense acquisition jobs. To help attain this goal, the Defense Acquisition University (DAU) was founded to coordinate the acquisition education and training programs to meet the training requirements of more than DoD acquisition personnel [Ref. 15]. The DAU sponsors curriculum and instructor training to provide a full range of basic, intermediate, advanced, and assignment-specific courses to support the career goals and professional development of the acquisition workforce. In addition to establishing the DAU, the DoD also established a process called the "Certification Program" through which acquisition personnel were recognized as having achieved professional status by meeting the professional standards of education, training and experience established for varying career levels. The certification standards included successful completion of mandatory training courses. While most of the required training courses were traditional classroom courses which were updated on a regular basis, DoD acquisition officials were concerned that the course content and thus the employees were not keeping up with the rapidly changing acquisition environment. Acquisition officials felt that acquisition specialists who had completed mandatory certification training years before, but had not had any additional interim training were not being kept current in acquisition-related matters [Ref. 14]. The USD(AT&L), formerly the USD(A&T), subsequently directed the development of a comprehensive continuous learning policy. The policy was designed to help acquisition personnel stay current in acquisition matters and meet performance expectations in a rapidly changing work environment [Ref. 16]. Titled *Reform Through Learning: USD (A&T) Policy on Continuous Learning for the Defense Acquisition Workforce*, this document outlines the requirements process for each member of the acquisition workforce.

The USD (AT&L) continuous learning policy is designed to augment other educational and training experiences, as well as job-related experience, and requires acquisition personnel to earn 80 continuous learning points every two years. A point is generally equivalent to one hour of education, training or developmental activity. Continuous learning points can be built from attending training courses, conferences, and seminars. Personnel may meet these standards by participating in five distinct areas which are: 1) functional and technical training, 2) leadership training, 3) academic courses at institutions of higher education, 4) experiential and developmental

assignments, 5) professional activities. Functional and technical training includes courses, conferences, seminars and comparable activities sponsored by DoD or its components and schools. Leadership training is considered an important part of the continuous learning process and includes education, training and related activities that provide exposure to leadership skills. Academic courses at institutions of higher learning can be used to satisfy the continuous learning standards, and the course content can vary from basic acquisition disciplines to advanced acquisition studies. Experiential and developmental assignments provide opportunities to learn from experience as part of a normal work assignment or through a rotational or developmental assignment that is specifically designed to provide a broadening experience. These opportunities earn continuous learning points because the ability to learn from experiences and apply the learning throughout one's career is considered a valuable skill. Professional activities, including the participation in acquisition-related professional organizations or associations, can be used to fulfill the continuous learning requirements. Participation may range from presenting papers at conferences and symposia, writing and publishing papers or teaching. The number of points earned for each of the above activities is shown in Table 2 on page 34. [Ref. 16]

The guidelines shown in Table 2 were modeled on the practices of a sample of professional societies representative of the acquisition career fields. Many professional societies and associations use a point system to evaluate the qualifications of applicants and certify them as meeting the organization's professional standards for membership. By using a point system, the organization is able to establish a common denominator for crediting and recognizing a variety of different activities that members can use to maintain their proficiency and professionalism. These guidelines are expected to be used as a basis for supervisors in arriving at values for specific continuous learning activities. It was developed as an aid intended to provide sufficient examples of creditable activities and a range of point values to assist the supervisor and employee in establishing point values. In cases where the application of the guidelines may be unclear, supervisors and employees are to identify an activity addressed in the guidelines that is most like the activity under discussion to arrive at a point value. Supervisors have the authority to establish points for activities that require interpretation. [Ref. 16]

Category	Creditable Activities	Point Credit (See Note 1)
Training:		
	DAU Certification Courses	10 Per CEU/See DAU Catalog
	DAU Continuin g Acquisition Training	10 Per CEU/See DAU Catalog
	DAU Assignment Specific Courses	10 Per CEU/See DAU Catalog
	Other Continuing Acquisition Training	1 point per 60 minutes instruction
	Team Training	1 point per 60 minutes instruction
	Mentor Training	1 point per 60 minutes instruction
	Training with Industry (See Note 2)	1 point per 60 minutes instruction
	Management/Leadership Training	1 point per 60 minutes instruction
	Equivalency Exams	See Note 3
Education:		
	Quarter Hour	10 Per Quarter Hour
	Semester	15 Per Semester Hour
	AA	10 (See Note 4)
	BS/BA	20 (See Note 4)
	MS/MA	30 (See Note 4)
	PhD	40 (See Note 4)
	Continuing Education Unit (CEU)	10 Per CEU
	Equivalency Exams	See Note 3
Experience:		
	On-the-Job Experiential Assignments	Maxim um 40 points in 2 years
	Rotation/Broadening Assignments	Maximum 80 points in 2 years
	Experience with Industry (See Note 2)	Maximum 80 points in 2 years
	IPT/Special Project Team Member	Maximum 20 points in 2 years
	IPT/Special Project Team Leader	Maximum 20 points in 2 years
	Mentor	Maximum 10 points in 2 years
Professional Activities:		
	Professional Examination, License or Certificate, e.g., CPA, PE	10 to 30 points (See Note 5)
	Active Association Membership	5 points
	Teaching/Lecturing (See Note 5)	2 points for each hour of presentation: Maximum 20 in 2 years
	Symposia/Conference Presentations (See Note 6)	2 points for each hour of presentation: Maximum 20 in 2 years
	Workshop/Conference Attendance	1 point per 60 minutes of content: Maximum 8 per day
	Publications:	See Notes 6 and 7
	Texts	25 to 40
	Technical Papers, Monographs, etc.	10 to 25
	Consulting (See Note 6)	10 to 25
	Patents	15 to 40 (See Note 5)

Notes:
1. Minimum requirement is 80 points over two years. Documentation and verification are the responsibility of the employee and supervisor.
2. The Intergovernmental Personnel Act and DoD Directive 1000.17, "Detail of DoD Personnel to Duty Outside the Department of Defense," apply.
3. Equivalency exams taken in lieu of completing a DAU training course, or an academic course, may receive the same number of points that would be awarded for actual completion of the course.
4. Points for degrees may be credited in addition to quarter hour or semester hour points, but only in the year in which the degree is awarded.
5. A professional license or a patent award may be counted only in the year initially received.
6. See Section V, Paragraphs D and E on pages 7 and 8 of this Policy for compliance requirements.
7. Publications may be credited only in the year published.

Table 2. Guidelines For Crediting Continuous Learning Activities (From. Ref. 16)

2. Aerospace Corporation and Aerospace Institute Model

The Aerospace Corporation is a private, nonprofit corporation that was created in 1960 at the initiative of the Secretary of the Air Force. The purposes of the corporation are exclusively scientific: to provide research, development, and advisory services. The Aerospace Corporation operates as a Federally Funded Research and Development Center (FFRDC) for the Department of Defense [Ref. 17]. An FFRDC is an organization that assists the United States government with scientific research and analysis, systems development, and systems acquisition [Ref. 18]. FFRDCs are independent, not-for-profit entities, with limitations and restrictions on their activities. This special standing permits a degree of access and a long-term perspective not shared by commercial contractors. All FFRDCs are sponsored by government agencies, but universities and other not-for-profit organizations privately administer them. As an FFRDC, the Aerospace Corporation provides technical support to a variety of space-related programs, although their primary customers are the Space and Missile Systems Center (SMC) of the Air Force Materiel Command and the National Reconnaissance Office (NRO). The Aerospace Corporation is recognized as a national resource and a center of technical excellence in meeting the special long-term research and development needs essential to developing a national military space program [Ref. 17]. The Defense Department has identified five core competencies for the Aerospace FFRDC: 1) launch certification, 2) system-of-systems engineering, 3) systems development and acquisition, 4) process implementation, and 5) technology application. Most of the corporation's work is hands-on engineering associated with the design, test, evaluation, and initial operation of space systems.

In 1994 the Aerospace Corporation developed the Aerospace Institute to educate its employees in space technology, systems architecture, and space engineering. To support this mission, the Institute created the Learning Systems Educational Center to provide educational programs. These educational programs meet a broad spectrum of objectives including technical education, business and leadership development, and computing skills. The technical education curricula address core competencies to promote the corporation's capabilities in the application of space technology. The curricula consist of a wide range of topics in space systems architecting, acquisition, and

engineering, as well as the technologies and engineering disciplines associated with space and space-related missions and systems. [Ref. 19]

In addition to providing educational programs, the Aerospace Institute also operates the Library and Information Resources Center and The Aerospace Press. The library provides access to an extensive collection of books, journals, and reports. The press publishes books and monographs on technical topics in aerospace science and technology as well as the *Crosslink*, the corporate technical magazine that provides information about the company's contributions to aerospace technology. The Institute also contributes to the development of technical knowledge sharing for customers and the broader aerospace community through conferences and symposia. [Ref. 19]

In 1995, the Institute piloted the Aerospace Systems Engineering Certificate Program which was designed to provide the technical staff with a broad space systems perspective. The curriculum that was developed for the certification consisted of an initial awareness segment, a knowledge and skills building segment, and a skills-reinforcement segment and is still employed today (see Figure 5, page 37). The initial awareness segment is a 30-hour core course that orients participants to evolving DoD and NRO customer and acquisition environments, surveys major Aerospace systems and provides lessons learned. The knowledge and skills building segment focuses on gaining in-depth understanding of state-of-the-art methodologies and tools and how to apply them in work assignments. The final segment is an on-the-job-training and internship program where participants apply principles learned in the classroom. [Ref. 20]

While the Aerospace Institute programs and services are primarily designed to meet the learning and professional development needs of Aerospace employees, some technical courses are available to customers outside the corporation. Eligible customers include active duty military and government civilians. Normally, Institute courses are not open to Reservists, consultants or government contractors.

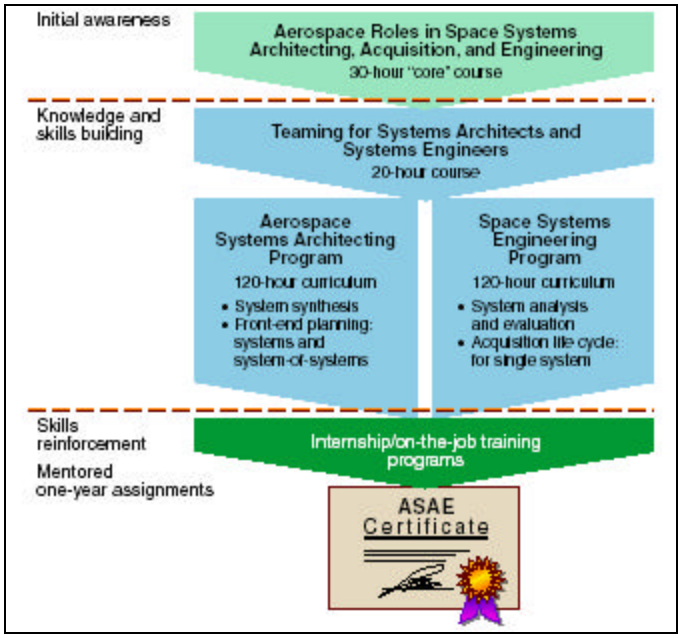

Figure 5. Aerospace Institute Certification Development (From Ref. 20)

C. PROPOSED SPACE CERTIFICATION MODEL

1. Rationale

The proposed model for space certification for Naval cryptologists was developed by applying learning continuum and distributed learning concepts from the Defense Acquisition Workforce as well as certification procedures from the Aerospace Institute. The proposed model is designed to be implemented in various stages and provides an avenue for expansion to include other officer designators in the Navy. It is also designed to be useful for assisting in training a space cadre if the Navy embraces that concept. The model proposed discusses both a near-term and a long-term solution to space education and training. Although the proposed model is for near-term space certification of Naval cryptologists, also proposed is an expansion of the model to include the Navy's space cadre.

In order to develop a viable space certification program in which cryptologists can participate regardless of the type or location of the billet they are occupying, the distributed learning concept was incorporated into this proposed model. Distributed

learning allows cryptologists stationed at sea or on shore, anywhere in the world, a means to participate. Additionally, the concept of continuous learning was incorporated into the model by providing a plan to allow cryptologists to continue their space education and training once begun. The model allows cryptologists to take responsibility for and direct their own learning and development in a variety of ways and on a continuous basis throughout their careers.

The proposed certification process was divided into two stages, the initial certification segment and the continuing certification segment. The purpose of establishing two segments was to first, provide a no-cost means of beginning the development of the program and second, to provide a variety of methods for cryptologists to maintain certification even if they are not provided the opportunity to become assigned to a space-related billet.

2. Initial Certification

The first segment was designed to be similar to the initial awareness segment of the Aerospace Institute certification process and would include completion of the following courses:

- SS3011 Space Systems Technology and Applications (NPS course). This is a web-based course that provides an introduction to space terminology, information on the physical factors that influence the use of space systems and an overview of the political, cultural, economic and organizational issues that influence how DoD uses space systems. It is designed to enable the student to provide the chain of command with recommendations for what to consider when including space systems in operational planning.
- SS3613 Military Satellite Communications (NPS course). This course is currently a classroom course but will soon be in a web-based format. It covers Military Satellite Communications (MILSATCOM) mission analysis, systems design, and applications. The course covers requirements, tactical employment, system architectures, satellite design

and performance, terminal design and performance, associated information systems, link budget calculations, telemetry and control and Information Operations (IO)/Information Warfare (IW) implications. The students are expected to create Satellite Communications (SATCOM) solutions for Navy and Marine scenarios.

- Collection Assets of the National Reconnaissance Office (NRO course). This course is a video presentation that introduces each NRO satellite constellation and gives a brief, thumbnail description of each mission within that constellation.
- National Reconnaissance Office (NRO) Systems (NRO course). This course consists of a series of videos that cover each NRO satellite constellation in depth. The NRO recommends that students view the Collection Assets of the NRO video before viewing these individual videos.
- Satellite, Aircraft and Missile Systems (NSA course). This course is a self-paced CBT course that provides basic information on types of satellites, satellite subsystems, their orbits and support facilities; types of aircraft, aircraft subsystems and flight dynamics; and types of missiles, principles of missile flight, and operation of the primary missile subsystems.
- Overhead Signals Intelligence (SIGINT) Collection (NSA course). This course is a web-based course that provides students with the basic understanding of overhead collection and collection management. The requirements and tasking process, the systems and their missions, the capabilities and limitations, the types of orbits, the procedures for building a task, and systems management are covered.

These courses were chosen because they represent a core of basic space-related courses as described in Chapter 4 of this thesis. The Space Systems Technology and Applications course was selected because it provides an overview of space systems essential for cryptologists to become conversant in space systems planning. The Military

Satellite Communications course was considered essential for cryptologists to earn space certification because the Navy is so heavily reliant on space assets for communications. The NRO courses were selected because they provide information essential for cryptologists to understand NRO satellite systems. The Satellite Aircraft and Missile Systems course was selected to provide cryptologists with a knowledge of the primary types of satellites and missiles as well as their characteristics and uses. The Overhead SIGINT Collection course was deemed essential to the certification because it provides information needed for a cryptologist to effectively provide SIGINT support to the warfighter.

3. Maintaining Certification

This segment was designed to combine parts of the Knowledge and Skills Building Segment of the Aerospace Institute model and the point system of the Acquisition Community model. The number of points required to maintain space certification is a minimum of ten points every two years. This points system is much less ambitious than that for acquisition professionals because space-related topics are only one of the eight core subjects a cryptologist needs to focus on (see Chapter V, paragraph B.4). The points could be earned from education and training courses, on-the-job experience, and professional activities as outlined in Table 3 on page 41.

The ten points necessary to maintain certification can be earned from any one of the four categories or from a combination of events from any of the four categories. The only restriction is that if courses outlined in the training category are used to earn all ten points, only five of the ten points can be earned from management and leadership courses. A discussion of each of the categories in the table is provided in the following paragraphs.

Category	Creditable Activities	Point Credit
Training:		
	National Reconnaissance Office or National Security Agency Space-related Courses (CBT/Video)	2 points per course completed
	National Reconnaissance Office or National Security Agency Space-related Courses (Resident)	1 point per 8 hours of instruction
	Cryptologic Department Head Course (currently under development)	1 point per 8 hours of space-related instruction
	Space training provided by other means	1 point per 8 hours of instruction
	Management/Leadership Training(Web-based or Correspondence)	2 points per course completed
	Management/Leadership Training (Resident) to include the Cryptologic Department Head Course as well as CNET courses	1 point per 8 hours of instruction
Education:		
	Naval Postgraduate School Courses	5 points per course
	Other universities/schools courses	5 points per course
Experience:		
	On-the-Job Experiential Assignments	Maximum 10 points in 2 years
Professional Activities:		
	Active Association Membership	2 points
	Teaching/Lecturing	2 points for each hour of presentation:
	Symposia/Conference Presentations	2 points for each hour of presentation
	Workshop/Conference/Seminar Attendance	1 point per day of attendance
	Publications:	
	Texts	5 to 10
	Technical Papers, Monographs, etc.	2 to 8

Table 3. The Proposed Space Certification Point System.

a. Training

The Training category of the proposed certification process includes DoD or government space-related educational courses and management and leadership courses. A list of possible courses is provided in Table 4 on page 43. This list is not intended to be all-inclusive but simply provides samples of the types of training courses that could easily be integrated into the beginning stages of a certification process. For cryptologists, inclusion of several NRO and NSA courses into the certification process seemed logical because cryptologists must already complete some of these courses as part of their professional development and also because Naval cryptologists have the appropriate clearances to have access to these courses. Additionally, there is already an established familiarity between CNSG and these organizations. The NRO and the NSA resident

courses can be taught at either the parent organization's locations or at field sites throughout the world.

The types of courses to be considered as space-related training by other means would include such courses as the previously mentioned USAF Interservice Space Intelligence Operations Course which is offered to all military service members.

In addition to space-related courses, this category also considers management and leadership courses as part of the certification process. As Naval officers, a continuing growth in leadership skills would enhance the readiness for an individual to effectively convey the Navy's space requirements when filling more senior space billets. As previously mentioned, management and leadership courses could account for five of the ten required points every two years. Many management and leadership courses are already available via the Navy's E-learning web site. This site provides training anytime, anywhere in the world to all Department of the Navy personnel. The source chosen for the management and leadership courses is the Navy's E-learning initiative. Navy E-Learning provides highly individualized, commercially available Computer-Based Training (CBT) for Information Technology (IT), Professional and Business development skills and Navy specific training [Ref. 21]. A leadership curriculum has been developed that includes both General Leadership Skills for Managers or Leadership Skills for Non-managers courses. A management curriculum has also been developed and includes courses in Coaching, Facilitating Groups, Managing Conflict, Managing Performance, Mentoring, Overcoming Negativity, and Understanding the Manager's Role [Ref. 21].

b. Education

The Education category has at its core the Naval Postgraduate School.

There are several advantages for including the Naval Postgraduate School in the certification process. First, individuals earning the certificate can earn college credits for the courses provided by the NPS. Secondly, the NPS has recently begun a distance learning initiative which will continue to increase accessibility to students who are not afforded the opportunity to be stationed at the NPS. Additionally, the NPS will soon

embark on the development of an education and training program for the newly established Information Professional (IP) community. The space certification process may some day be applicable to members of the IP community in the performance of their duties.

In addition to the NPS space-related courses, any accredited university or school that provides courses in space topics would be considered as acceptable for the point system. The credits for these courses could be earned in the traditional classroom environment, in a continuing education environment, or by successfully completing equivalency exams.

Space-Related Courses		
Organization	**Courses**	**Format**
NRO		
	National Imagery Intelligence Systems Education Program	Video
	National Signal Intelligence Systems Education Program	Video
	Tactical Data Dissemination System (TDDS) and Tactical Data Information Exchange System-B (TADIXS-B) User's Briefing (TTUB)	CD-ROM, lecture, classroom
	NRO Systems Support to Operations (NSTO) Presentation	CD-ROM
	NRO Systems Instructor Course (NSIC) Computer Based Training	CD-ROM
	National Reconnaissance Office (NRO) Systems	Video
	Current Imagery Systems Overview	Brief
	LSPO Education Course	Resident
NSA		
	Satellite Systems Fundamentals	Resident
	Introduction to Satellite Collection	CBT (under development)
	Introduction to Satellite Communications	Resident
	Satellite Systems Seminar	Resident
	National SIGINT Systems	Resident
Management and Leadership Courses		
CNET		
	Officer Leadership (Basic, Intermediate, Advanced, Command)	Resident
	Management to Leadership Courses	Navy e-learning
	Leadership in Senior Management	Navy e-learning
	Leading the Workforce Generations	Navy e-learning
CNSG		
	Cryptologic Department Head Course	Resident

Table 4. Proposed Training Courses

c. Experience

An individual can earn all ten minimum certification points by serving in a space-related billet. It is assumed for the purposes of this certification process that cryptologists generally are not assigned to consecutive space-related billets. Thus, while experience points would be earned for the duration of a space-related assignment, eventually the cryptologist would be in a situation where certification points could not be earned from the experience category but would have to be earned from the other categories. Documentation and verification of experience points would be the responsibility of the individual and the supervisor. Space-related assignments for cryptologists include, but are not limited to assignments at CNSG Headquarters, Naval Security Group Activity (NSGA) field sites and detachments, the NRO, the NSA and the Space and Naval Warfare Systems Command (SPAWAR). A complete enumeration of space-related billets that would provide experience points will be necessary before program implementation. Space-related billets are not limited to the established "P" coded billets that are generally occupied by NPS Space Systems Operations graduates.

d. Professional Activities

Professional Activities include active membership in a professional association or society, teaching or lecturing, presenting topics at conferences or seminars, or attending conferences or seminars. Active membership in an association or society includes participation in association-related activities including teaching, presenting papers, and writing on topics related to one's expertise as part of that association. Participation in the some of the possible associations that could be considered to be related to the certification process are the American Institute of Aeronautics and Astronautics (AIAA), the American Astronautical Society (AAS) or the Society of Satellite Professionals International.

Teaching space-related courses or topics is also considered a way to earn points for continued certification. Cryptologic personnel teach courses that have space-related segments at the Naval Technical Training Center (NTTC), Corry Station, Pensacola, FL. In addition to teaching courses, cryptologic personnel who take part in

the development of these courses can also earn points. Additionally, military personnel often teach both the NRO and the NSA courses. Military instructors are called upon to provide NRO systems instruction in various settings. At the NSA, military personnel participate in the adjunct faculty program which is designed to assist the National Cryptologic School (NCS) in providing qualified instructors for NCS courses. An adjunct faculty member teaches, develops, manages or evaluates courses at least once every two years to stay current.

Presenting topics at symposia or conferences is another method of earning points. Examples of the types of conferences or seminars where presentations could be made to earn space certification points include the Warfighter's Space Conference sponsored by the NRO or the O-4/O-5 Cryptologic Seminar. These examples are also representative of the types of conferences and seminars where attendance points can be earned.

4. Administrative Issues

Various administrative issues, such as documentation, record keeping, and certification issuance, have been considered for the space certification process for cryptologists. Documentation and record keeping for initial certification could occur at individual command training offices of various cryptologic commands. Once a Naval cryptologist has completed requirements for the initial certification, a letter could be sent from the command to CNSG N7 who would have the responsibility of issuing the certification. Upon receipt of certification, notation would be made in the individual's service record and in the subsequent fitness report. It will be up to the individual service member to ensure documentation of the certification process is complete.

Administering the certification maintenance portion of the program is more complicated because of the use of the point system. An individual will submit paperwork to his or her senior describing how points for continued certification were earned. After the individual's senior endorsed the paperwork, the local command training office would once again document the information in the individual's training

record. Annotation that the requirements to maintain space certification were met would again be placed in service records and in fitness reports.

VII. CONCLUSIONS AND RECOMMENDATIONS

Web-based courses extend the footprint of the classroom to many locations which is especially important for Naval personnel who are widely dispersed throughout the world. While computer-mediated methods of training won't completely replace resident education and training methods, there are instances that call for a non-traditional classroom environment. The proposed Space Certification program is one of those instances. The proposed program incorporates the concept of a learning continuum because it is designed to provide a variety of opportunities throughout a person's career for maintaining space-related credentials. The proposed program also embraces the Navy's Distributed Learning policy by incorporating web-based training as the core of the process providing educational opportunities outside of the classroom setting. It also incorporates distributed learning initiatives that have already been developed by the Navy and other organizations, reducing the amount of development time needed to begin implementing the program.

The proposed cryptologic space certification process could serve as a framework that would allow expansion of the program to include other officer designators. The initial certification process would have to be revised to include courses that don't require a clearance level that many other communities, as a rule, don't maintain. If the program was expanded to include other officer designators, the following should be explored:

- The use of additional NPS courses to include current and future courses offered as a part of the NPS Distributed Learning Program. As part of this initiative, the Office of Continuous Learning (OCL) has been established to assist with developing partnerships in the development, delivery and assessment of distributed learning [Ref. 22]. The OCL could become the organization that forms the partnerships with other entities that currently have space-related courses.
- The use of courses such as those available through corporations like the Applied Technology Institute (ATI), an organization that provides professional development through continuing education training [Ref. 23].

The ATI provides courses, seminars and on-site training about the latest developments and projects in spacecraft, sonar, radar and Navy technology. The ATI already has an established partnership with the USN and provides on-site courses at major Navy research centers. Table 5 on page 49 provides examples of the types locations of space-related courses offered by ATI. Although ATI courses are currently only available in a resident format, the courses can be tailored to a particular audience and provided on-site at a customer's location.

- The use of the Aerospace Institute's courses for certification purposes. Table 6 on page 50 provides examples of the courses available [Ref. 24]. As an FFRDC, the Aerospace Corporation is under a government contract to provide technical services to its customers. These services include participation in technical education courses offered by the Aerospace Institute. Currently, there are few Navy organizations that are included in the Aerospace Corporation contract. Thus there are few Navy personnel eligible to attend the Aerospace Institute classes. A future goal would be to explore how to get the contract adjusted to include personnel designated for space certification [Ref. 25]. To begin this process a correspondence would need to be initiated with the Aerospace Institute's Executive Director at (301) 336-5213 or http://info.aero.org/tai.

If the proposed space certification model is expanded to include officers other than cryptologic officers, and if the expansion includes using courses at universities (other than NPS) or at civilian institutions, the subject of tuition reimbursement must be addressed. It is recommended that the current process used by the Defense Acquisition Workforce for reimbursing its personnel be explored. The Department of the Navy (DoN) also has established a tuition assistance program for employees in the acquisition workforce to provide funding for tuition costs associated with education requirements established by the DAWIA. This tuition assistance program could provide the framework for space certification program reimbursement. Further exploration of the process the Defense Acquisition Workforce uses to establish experience points is also necessary before program establishment.

Title	Location
Advanced SAR	Dulles Airport Area/VA
Aerospace Power Systems	Washington DC/MD
Antenna Principles & Design	Orlando, Fla.
Attitude Determination & Control	Washington DC
Fundamentals of Orbital & Launch Mechanics	Cape Canaveral, FL
Fundamentals of SAR	Dulles Airport Area/VA
Geomatics - GIS, GPS & Remote Sensing	Washington DC/MD
GPS Technology	Washington DC/MD
Ground System Design & Operation	Washington DC/MD - BWI
Hyperspectral/Multispectral Imaging	Washington DC/MD
Launch Vehicle Performance & Use	Dulles Airport Area/VA
Model-Based Design for Space Systems	Washington DC/MD
Passive Microwave Remote Sensing	Washington DC/MD
Remote Sensing Satellites	Washington DC/MD
Risk Assessment for Space Flight	Washington DC/MD
Satellite Communication Systems Engineering	Los Angeles, CA Area
Satellite Communication Systems Engineering	Washington DC/MD
Satellite Design & Technology	Cape Canaveral, Fla.
Satellite RF Comm. & Onboard Processing	Washington DC/MD
Space Environment	Washington DC/MD
Space Systems I	Washington DC/MD
Space Systems II	Washington DC/MD
Spacecraft Quality Assurance and Testing	Washington DC/MD
Spacecraft Systems Design & Engineering	Washington DC/MD

Table 5. ATI Space-Related Courses (From Ref. 23).

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Space Systems Architecting, Acquisition and Engineering	Space Technology and Engineering Disciplines
Advanced Space System Concepts for 2000-2030	Adaptive Antenna Principles, Algorithms, and Applications
Aerospace Roles in Space Systems Architecting, Acquisition, and Engineering	Applications and Number Theory
Aerospace Systems Architecting Pro gram	Attitude Determination Systems
Art and Science of Systems Architecting	Communication Systems Technologies Lecture Series
Concept Development	Computer Systems Technologies (New Technology Overview Series)
Cost and Schedule Engineering Management	Digital Communications and Spread Spectrum
Cost Estimation and Analysis	Geometrical Aspects of Dynamics
Cost Risk Analysis	Global Positioning System for Attitude Determination
Defense and Intelligence Systems Acquisition Overview	Information Security Overview
Developing and Managing Systems Requirements	Inspecting Object-Oriented Work Products Using UML
Earned Value Management	Introduction to Gravitation
Evaluating Software Development Capability	IR Sensors
Global Positioning System: Principles and Applications	Microwave Principles and Applications
Requirements Management	Nonlinearity - Analysis and Applications
Risk Management	Object-Oriented Concepts and Applications
Software Acquisition and Software Engineering in Today's World	Object-Oriented Overview
Space and Launch Vehicle Systems	Orbital Mechanics
Space Systems Design	Precision Pointing Systems
Space Systems Development, Integration, and Test	Satellite Orbit Analysis Program (SOAP)
Space Systems Operations	Space Communications Introduction
Space Systems Overview	Space Communication System Components
Space Systems Program Management 1	Spacecraft Attitude Dynamics and Control
Space Systems Program Management 2	Spacecraft Payloads Review
Space System Test and Verification: What? When? Why?	Spread Spectrum Systems

Table 6. Aerospace Institute Space-Related Courses.

APPENDIX. WEB-BASED DEVELOPMENT CONSIDERATIONS

This appendix provides an overview of the approaches to developing a web-based course and the process of developing faculty who are proficient in teaching web-based courses.

A. DEVELOPING A WEB-BASED COURSE

A web-based approach to providing education and training to military personnel may seem the optimum solution because of possible cost savings and accessibility issues. However, the military should assess the same considerations that civilian institutions take into account prior to making the decision to develop a web-based course. One approach that can be taken before embarking on a web-based solution is to address the following questions: 1) What are the learning objectives for the course? 2) Can the learning objectives be met through a course design that includes the World Wide Web? If so, is software/hardware available that would be appropriate/suitable for the course? 3) Are the system resource, technological support and faculty/student support available to make the course successful? 4) How will assessment occur of both the learning outcomes and the overall distributed learning web-based development program? 5) How will the content be maintained and refreshed?

In the case of appropriateness, the content material of the course and the learning objectives should be reviewed. The course needs to be assessed objectively as to its suitability for online presentation. Teaching online is quickly becoming a popular thing to do but that does not necessarily mean that all instruction, in its current form, is suitable for the virtual classroom. [Ref. 26]

After it has been determined that the course is suitable for online instruction, the next step is to match the course content to the most appropriate software. If the content material calls for a course that is primarily procedural in nature (consists of a textbook and possibly some handouts and is presented without discussion) then the software chosen would not necessarily need to include features such as whiteboards, video, etc. If the course content requires synchronous or asynchronous interactive participation on the

part of the students or requires audio or video features, then selecting a software application that has the appropriate support systems is a must. Knowledge of the software and hardware options available and how the options will support the course content is necessary key in choosing the appropriate software. [Ref. 26]

Lastly, an assessment of the resources available, both those at the institution sponsoring the course and those of the students, will need to be made for an online course. The sponsoring organization should have someone, such as an instructional designer, available to help with the course development. The instructional designer should also work with the organization's information technology staff to ensure that end-to-end technology infrastructure is adequate to support the course learning objectives and the chosen instructional design. [Ref. 26]

The Navy DL strategy combines much of the same elements as described above and includes addressing the following questions [Ref. 5]:

- What content should remain in the formal setting?
- What content should be distributed via web-based methods?
- What content needs to reach a large, disbursed student population (i.e., core instruction modules)?
- What content can be repurposed to meet a wide range of learning requirements?
- What are the parameters and constraints for distributing the instruction?
- What forms of distributed learning (i.e., Web-based training, computer-based training, video teletraining) are appropriate to present the content under what circumstance?
- Are commercial-off-the-shelf (COTS) instructional modules available?
- Are acceptable education and training resources available from external sources?

An important point to note is that the Navy approach seeks to use commercially available items or other external resources where appropriate, which can minimize web-

based course development time. This approach minimizes the amount of development time and alleviates the need for having personnel with the knowledge and experience in these techniques.

B. FACULTY DEVELOPMENT FOR WEB-BASED CURRICULA

A well-trained, prepared and supported faculty is key to providing quality web-based courses, as well as other distributed learning courses, and ensuring student success. The University of Central Florida (UCF) is an award-winning member of the United States Distance Learning Association and has become one of the leading sources of information and recommendations for government agencies, Congress, industry and those entering into the development of distance learning programs [Ref. 27]. The UCF has developed a program to help faculty prepare to develop and to teach distributed learning through its Course Development and Web Services Center. This center has become a model for other institutions to develop similar programs for preparing faculty to teach in a web-based environment which has resulted in UCF forming partnerships with other educational institutions. One of these partnering institutions is the Naval Postgraduate School. This partnership began as a faculty development activity provided through the Naval Air Warfare Center Training Systems Division (NAWCTSD). The partnership between UCF and NPS currently focuses on the development and provision of a faculty development program for online teaching and course development with the NPS Distributed Learning Resource Center. As the NPS Distributed Learning initiative progresses, the NPS and the UCF will be collaborating on research and other DL development activities.

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